



measnet

INTERNATIONAL NETWORK OF WIND ENERGY
MEASUREMENT INSTITUTES

26PP01

Power Performance Proficiency Test

PT Scope & Calendar

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1. Introduction & Methodology

Within the framework of the MEASNET network internal quality evaluation program, the collaboration with the IECRE organization and the consideration of proficiency testing as a service offered to its customers, a Power Performance Proficiency Test is to be organized and performed.

1.1. Standards in Scope

The participants shall perform the tasks according to the standards IEC 61400-12-1:2022 [1], IEC 61400-12-3:2022, IEC 61400-12-5:2022 and IEC 61400-50-1:2022 and the corrigenda IEC 61400-12-1:2022/COR1:2025, IEC 61400-12-3:2022/COR1:2025 and IEC 61400-12-5:2022/COR1:2025.

1.2. Methodology

According to the IECRE O.D. 551-17 [8], the Proficiency Test will be performed in two rounds.

Round 1 is a preparation phase intended to find the sources of the differences among the participants, and is restricted to type A participants.

Round 2 is open to type A and type B participants. The Pass and Fail Criteria proposed below shall be used by IECRE to determine the proficiency of the laboratories belonging to the system.

1.3. Preliminary Line Choice

For this Power Performance Proficiency Test some preliminary line choices have been defined. The selected choices are defined in chapter 2 of this proposal.

2. Topics covered by the PT

2.1. General Comments

2.1.1. Rounding

During the analysis of the raw data of the results the participants results may be provided with incorrect rounding in deviation to the request. This leads to unnecessary deviations. The problem here may be that the results have been rounded in Excel in format only, but not the numbers themselves. Therefore, the Measnet expert group recommends including a statement in the instructions, which clearly states that the results have to be rounded by numbers. The rounding shall be applied to the final number which shall be presented, e.g. if there is a percentage value like 0.234525%, the rounding of three digits would be 0.235%, not 0.2% (rounding of 0.00234525).

The Technical Coordinator, upon receipt of the participants' results, shall verify that the requested rounding has been implemented and notify the Organizational Provider in case any participant neglected to follow the rules. The Organizational Provider shall require the involved participants to update their results and re-submit them within 5 working days.

2.1.2. Sensor data sheet

Data sheets of sensors will be avoided and explicit input parameters will be provided instead (please see below for precise proposals).

2.2. Site Calibration (SC)

2.2.1. Site Calibration correction factors

The SC correction factors are proposed to be calculated for Method 1 based on a ready to use dataset. The maximum allowed difference is 0.001 from the median value in each cell of the wind direction/shear matrix (4 digits after decimal). A supplement Z-score metric (defined as the deviation from the median divided by the standard deviation) will be also applied. The participants should report results ONLY for the cases fulfilling the completion criteria A and B of section 9.3 of the standard [1]; the

non-mandatory option (C) will not be applied; As an informative test, with no pass/fail criteria, the participants shall provide, for one specified wind direction sector, the average residual values (Formula 3 of [2]).

The informative test will be only performed in Round 1.

2.3. Site Calibration uncertainties

The site calibration uncertainty shall be calculated based on the dataset of exercise 2.2.1. The analysis shall be performed for the most-populated wind direction sector and be reported at 6, 10 and 14 m/s in terms of the Type-B uncertainty components. The Type-A uncertainty will not be calculated.

The Type-B uncertainty components to be applied are according to section E.9.2 of the standard [1]:

- E.9.2 Pre-calibration: to be derived from datapack material.
- E.9.3 Post-calibration: to be derived from datapack material.
- E.9.4 Classification: classification B index will be provided.
- E.9.5 Mounting: to be derived from datapack material.
- E.9.6 Lightning finial: ignored.
- E.9.7 DAQ: ignored.
- E.9.8 COC: to be derived from datapack material.
- E.9.9 RMV: ignored.
- E.9.10 SV: to be derived from datapack material.

The SC uncertainty result shall be presented as a percentage value with 2 digits after decimal e.g. 1.45%. The maximum allowed difference from the median is 10% of the value or 0.1% (percentage points) (whichever is larger). A supplement Z-score metric (defined as the deviation from the median divided by the standard deviation) will be also applied.

2.4. Power Curve (PC)

2.4.1. Power Curve Site Specific

A ready-to-use dataset will be provided to the participants (no filtering required). The participants shall provide the calculated site-average air density value in 3 decimal digits. The normalization shall be done to a site-specific air density value, which will be provided in the PT instructions to avoid deviations due to potential deviations in the selected reference air density.

The maximum allowed difference from median value is 0.1% or 1 kW (whichever is larger) in each wind speed with a nominal center value ≥ 3 m/s. Bins below 3 m/s are not included in the pass/fail decision because they have a trivial contribution to the AEP (typically less than 0.2% for average speed 4 m/s) and are difficult to assess in relative percentage units due to the small power values expected in those bins.

2.4.2. Power Curve Uncertainties

The following specifications shall be applied:

- The values and/or assumptions of the uncertainty components to be included in the calculation will be provided.
- Only present complete BINs.

The sensitivity coefficients shall be calculated as in Table E.2 of [1] and in sections E.10.2, E.10.7 and E.10.11.

The following shall be also applied:

- The air density-correction uncertainty component shall be calculated and included.
- As an Informative Exercise the Verification of Results will be tested according to Annex A of [2].

The maximum allowed difference of the combined uncertainty (type A and B components) from median is 10% for wind speed bins above 3 m/s. An assessment is not performed for bins below 3 m/s. The uncertainty values for each wind speed bin shall be reported in 3 decimal digits (kW). A supplement Z-score metric (defined as the deviation from the median divided by the standard deviation) will be also applied.

2.5. Annual Energy Production (AEP)

A data set shall be provided as a binned PC.

Furthermore, only given BINs for AEP calculation shall be used. No interpolation shall be performed for “intermediate” incomplete bins.

2.5.1. AEP measured

Participants shall provide the calculations in kWh. No decimal digits required. The maximum allowed deviation from the median value shall be 0.1% for average speeds 6 to 11 m/s and 0.2% for 4 and 5 m/s.

2.5.2. AEP extrapolated

Participants shall provide the calculations in kWh. No decimal digits required. The maximum allowed deviation from the median value shall be 0.1% for average speeds 6 to 11 m/s and 0.2% for 4 and 5 m/s.

2.5.3. AEP uncertainties

The uncertainty components to be applied will be provided in the instructions. The maximum allowed difference of the combined uncertainty (type A and B components) from median value is 10%. A supplement Z-score metric (defined as the deviation from the median divided by the standard deviation) will be also applied. The uncertainty values for each wind speed distribution shall be reported in kWh. No decimal digits required.

The following specifications shall apply:

- Formula E.58 with its definition of f_i shall be used. Also respect the note in Table E.2 (p.64) for $c_{v,i}$.
- The bin wise summation of the AEP uncertainties shall start with the second bin.

2.6. Data filtering

No density correction shall be applied.

No individual filters shall be applied; only the following filters shall be applied:

- Wind direction
- Status
- Icing filter (temperature $<2^{\circ}\text{C}$ and $\text{RH}>80\%$)
- Abnormal conditions or sensor malfunction

The binwise number of records in the valid dataset shall be reported by each participant; the applicable rule for bin bounds shall be $[x_1, x_2)$. The maximum allowed difference is ± 1 record from median value for wind speed bins ≥ 3 m/s.

2.7. In-situ comparison

The data set shall be provided by the PT conductor. The first and second period shall be clearly provided by the instructions as well as the sector in which the check of Section 9 of [4] will be applied.

The standard proposes two binning options. The comparison shall be done following binning option 1. To avoid misinterpretations regarding the wind speed bins to be reported, the instructions shall state that the bins to be used will be $[4.0, 5.0)$, $[5.0$ to $6.0)$,..., $[11.0, 12.0)$ m/s.

The participants shall report the value δ (quadratic sum of the systematic deviation and statistical uncertainty) from equations 25 and 26 of [4] providing 3 digits after decimal. It should be noted that the rightmost part of 26 is mathematically incorrect; the correct form will be included in the instructions.

The pass/fail criteria of the deviation from the group median shall be classified as an absolute deviation of 0.01 m/s

2.8. Terrain evaluation

The pass/fail criteria of the deviation from the group median are based on the Z-score metric of each participant. This is defined as the deviation from the median divided by the standard deviation. The acceptance limit is $Z \leq 2$. The Z-score is calculated for the slope and for the value of the maximum terrain variation from plane for each distance circle and for each of the Test turbine and Reference Mast positions.

2.9. Obstacles evaluation

Extended obstacles will not be included in the list of the provided dataset.

The pass/fail test shall apply to the determination of the combined measurement sector. The maximum allowable difference from the median shall be 0.2 deg for each of the sector(s) start / end.

3. Pass / Fail Criteria

The RETLs belonging to IECRE must fulfil the following Pass and Fail Criteria in order to be part of the IECRE system. They are not mandatory for other participants.

The individual target limits for each of the assessed tasks presented in the previous sections will be applied in Proficiency Test Round 2 to determine the PT result for each participant. The rules to reach the decision are provided in Table 3.1.

Three categories of rules are defined:

- A. Tasks where a hard limit (target) is used and no yellow level is applied. The exceedance of the hard limit leads automatically to RED level for the particular task.
- B. Task where a hard limit (target) is used in combination with a Z-score metric (deviation from the median divided by the standard deviation). Applies mainly to Non-Normative Context of the IEC 61400-12-1, Ed.3, in particular uncertainty calculations. The GREEN level is achieved by either complying EITHER to the hard limit OR to a strict Z-score ≤ 1 . The YELLOW level is achieved when the Z-score lies between 2 and 3. Otherwise, RED level is reached.
- C. For the terrain task no red level has been defined, since it is considered that a fail in this task should not directly imply a fail result in the Proficiency Test.

The Decision Rules are:

- The result of a participant is PASS if the GREEN LEVEL has been achieved in all the tasks OR the YELLOW LEVEL has been reached in up to 3 tasks.
- The result of a participant is FAIL if the RED LEVEL has been reached in any task.
- The result of a participant is FAIL if the YELLOW LEVEL has been reached in more than 3 tasks.

All results in the YELLOW level should be explained in a deviation report.

A RETL participant that has failed in the PT is entitled to initiate a Correction Phase according to [8].

Table 3.1 Pass / Fail Criteria and Decision Rules

Site Calibration Correction Factors			
<i>Calculate the wind speed ratio V_{turb}/V_{ref} for each cell of the wind direction/shear matrix.</i>			
<i>The median value will be calculated for each of the completed cells of the matrix, as defined in the Instructions Guide of the PT.</i>			
<i>The median value of the ratio is calculated for each assessed cell. The deviation of each participant from the median will be calculated.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation ≤ 0.001 from median value in each of the assessed matrix cells</i>	Compliant in all cells	Deviation > 0.001 in one or more cells	Deviation > 0.001 in one or more cells
	OR	AND	AND
<i>For each cell the Z-score (deviation from median/divided by standard deviation) of the participant is calculated</i>	$Z \in (0,1]$ in all cells	$Z \in (1,3]$ in one or more cells	$Z \in (3,\infty)$ in one or more cells
Site Calibration Uncertainty			
<i>The combined uncertainty of the site calibration will be calculated at 6, 10 and 14 m/s and given as a % value.</i>			
<i>The median value will be calculated for each of the 3 test wind speeds.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq \max\{10\% \text{ of median value}; 0.1\%$</i>	Compliant in all cells	Deviation $> \max\{10\% \text{ of median value}; 0.1\%$ in one or more cells	Deviation $> \max\{10\% \text{ of median value}; 0.1\%$ in one or more cells
	OR	AND	AND
<i>For each of the test wind speeds, the z-score (deviation from the median value divided by the standard deviation) of each participant is calculated.</i>	$Z \in (0,1]$ in all cells	$Z \in (1,3]$ in one or more cells	$Z \in (3,\infty)$ in one or more cells
Power Curve			
<i>The bin-averaged power value will be calculated for each wind speed bin as per the instructions.</i>			
<i>The median value will be calculated for each wind speed bin.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq \max\{1 \text{ kW}; 0.001 \times P\}$ from median value in each bin with nominal central value $\geq 3 \text{ m/s}$</i>	Compliant in all bins		Non-compliance in one or more bins
Uncertainty of Power Curve			

<i>The bin-averaged combined uncertainty of the power value [kW] will be calculated for each wind speed bin as per the instructions.</i>			
<i>The median value will be calculated for each wind speed bin.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq 10\%$ from median value in each bin with nominal central value ≥ 3 m/s.</i>	Deviation $\leq 10\%$ of the median in all tested bins	Deviation $> 10\%$ of the median in any tested bin	Deviation $> 10\%$ of the median in any tested bin
	OR	AND	AND
<i>For each wind speed bin, the Z-score (deviation from the median value divided by the standard deviation) of each participant is calculated.</i>	$Z \in (0,1]$ in all tested bins	$Z \in (1,3]$ in one or more tested bins	$Z \in (3,\infty)$ in one or more tested bins
AEP-measured			
<i>The results for Rayleigh distributions with average 4,5,6,..., 11 m/s are calculated.</i>			
<i>The median value will be calculated for each distribution.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq 0.1\%$ of median at 6,7,...11 m/s, deviation $\leq 0.2\%$ of median at 4 and 5 m/s.</i>	Compliant for all distributions		Non-compliance in one or more distribution
AEP-extrapolated			
<i>The results for Rayleigh distributions with average 4,5,6,..., 11 m/s are calculated.</i>			
<i>The median value will be calculated for each distribution.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq 0.1\%$ of median at 6,7,...11 m/s, deviation $\leq 0.2\%$ of median at 4 and 5 m/s.</i>	Compliant for all distributions		Non-compliance in one or more distributions
Uncertainty of AEP-measured			
<i>The results for Rayleigh distributions with average 4,5,6,..., 11 m/s are calculated.</i>			
<i>The median value will be calculated for each distribution.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation $\leq 10\%$ of median at each distribution.</i>	Compliant in all distributions	Non-compliance in one or more distributions	Non-compliance in one or more distributions
	OR	AND	AND
<i>For each distribution, the Z-score (deviation from the median value divided by the standard deviation) of each participant is calculated.</i>	$Z \in (0,1]$ in all distributions	$Z \in (1,3]$ in one or more distributions	$Z \in (3,\infty)$ in one or more distributions

Data filtering			
<i>The number of valid records will be calculated for each wind speed bin as per the instructions.</i>			
<i>The median value will be calculated for each wind speed bin.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation ≤ 1 from median value in each bin with nominal central value ≥ 3 m/s.</i>	Compliant in all bins	Deviation between 2 and 3 records for any bin between 3 and 25 m/s	Deviation > 3 records for any bin between 3 and 25 m/s
In-situ comparison			
<i>The deviation δ value will be calculated for each wind speed bin as per the instructions.</i>			
<i>The median value will be calculated for each wind speed bin.</i>			
	GREEN	YELLOW	RED
<i>Target value: Deviation ≤ 0.01 m/s from median value in each bin.</i>	Compliant in all bins	Non-compliance in one bin	Non-compliance in two or more bins
Terrain evaluation			
<i>For a given measurement sector, test turbine/reference mast configuration and elevation datafile calculate the maximum slope and maximum terrain variation from plane in each of the 5 distance circles.</i>			
<i>For each result (total: 8), the Z-score (deviation from the median value divided by the standard deviation) of each participant is calculated.</i>			
	GREEN	YELLOW	
<i>Target value: Z-score ≤ 2</i>	$Z \in (0,2]$ in all results	$Z \in (2,\infty)$ in one or more results	
Obstacles evaluation			
<i>Given the neighbouring turbines and obstacles, the measurement sector is calculated.</i>			
	GREEN	YELLOW	RED
<i>Target value for start and end of each segment of the final measurement sector: Deviation ≤ 0.2 deg from respective median value.</i>	Compliance for all values	Deviation (0.2, 0.5) degrees in any value	Deviation > 0.5 degrees in any value

FINAL PARTICIPANT RESULT	PASS	PASS (correction plan advised)	FAIL 6.1.5 [8]
	All results are GREEN	Up to 3 (inclusive) results are YELLOW	One or more results are RED
			OR
			More than 3 results are YELLOW

4. Proficiency Test Calendar

Preparation:

Application period deadline for Round 1	06.02.2026
Election of coordinator & participation appeals	31.03.2026
Fees payment deadline for R1 participants	01.04.2026

Round 1 (R1):

R1 instructions delivery	09.04.2026
R1 results submission deadline	15.05.2026
R1 data analysis from conductor	18.05.2026 to 12.06.2026
R1 results discussion	15.06.2026 to 26.06.2026

Round 2 (R2):

Application period deadline for R2	03.07.2026
Fees payment deadline for R2 participants	09.07.2026
R2 instructions delivery	24.07.2026
R2 results submission deadline	18.09.2026
R2 data analysis by conductor	21.09.2026 to 23.10.2026
R2 results communication & room for non-technical corrections	26.10.2026 to 06.11.2026
R2 participant report creation	09.11.2026 to 04.12.2026
Final public report releasing	Date subject to IECRE Lead assessors' availability for correction plan evaluations

Please note that according to the IECRE procedure, delays can occur if Clarification Sheets are issued during the PT.

5. Results provided by participants

The participants will provide their results in numerical format in designated excel tables for the particular phases.

The Measnet organization will take care of the data and guarantee that the data are treated anonymously, so the PT conductor does not know the results of the other participants in advance nor the author of each result sheet.

6. References

- [1] IEC 61400-12-1, Wind Energy Generation Systems , Power performance measurements of electricity producing wind turbines, 2022.
- [2] IEC 61400-12-3, Wind Energy Generation Systems , Power performance – Measurement based site calibration, 2022.
- [3] IEC 61400-12-5, Wind Energy Generation Systems , Power performance – Assessment of obstacles and terrain, 2022.
- [4] IEC 61400-50-1, Wind Energy Generation Systems , Wind measurement – Application of meteorological mast, nacelle and spinner mounted instruments, 2022.
- [5] IEC 61400-12-1:2022/COR1:2025.
- [6] IEC 61400-12-3:2022/COR1:2025.
- [7] IEC 61400-12-5:2022/COR1:2025.
- [8] IECRE OD-551-17, Edition 1.0, IECRE, 2020-08-17.
- [9] IECRE OD-551-24, Edition 1.0, IECRE, 2020-12-08.